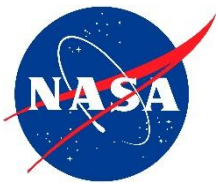




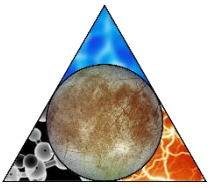
Planned Europa Mission Update: Beyond Payload Selection

Todd Bayer, Karen Kirby, Brent Buffington, Jean-Francois Castet, Maddalena Jackson,
Gene Lee, Kari Lewis, Jason Kastner, Kathy Schimmels
NASA -JPL / California Institute of Technology
Johns Hopkins University Applied Physics Laboratory

IEEE Aerospace Conference
5 March 2015

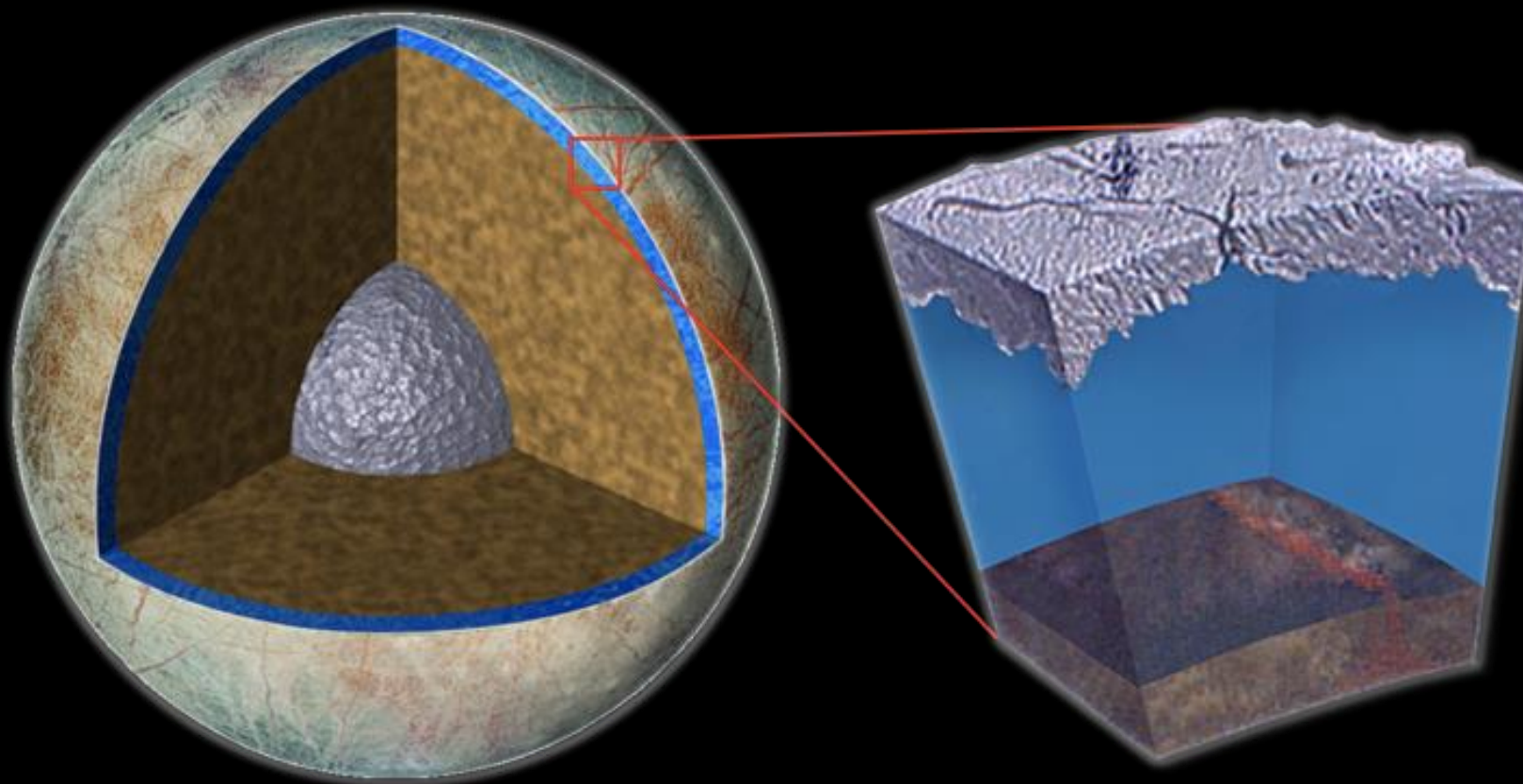


Topics



- Reminder: Why Europa?
- Long road to the current concept
- Major Changes since 2015
- Science instrument accommodation
- Flight System Configuration
- Key Trades
- Interplanetary Trajectory – Baseline and Alternate
- Tour Design
- Project Schedule
- Mission Timeline
- What's next

The Ocean That Beckons



*“Europa, with its probable vast subsurface ocean sandwiched between a potentially active silicate interior and a highly dynamic surface ice shell, offers **one of the most promising extraterrestrial habitable environments**, and a plausible model for habitable environments beyond our solar system”*

“Visions and Voyages”, 2011 Planetary Decadal Survey

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Europa: Ingredients for Life?

Water:

- Probable saltwater ocean, indicated by surface geology and magnetic field
- Possible lakes within the ice shell, produced by local melting

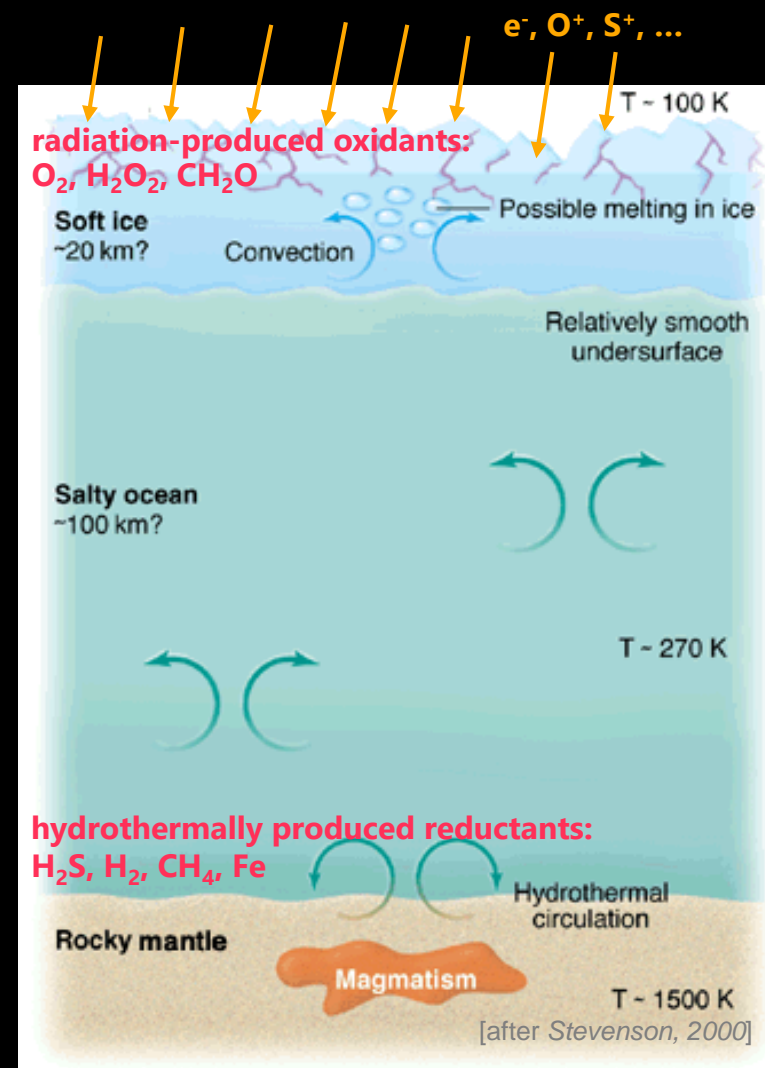
Chemistry:

- Ocean in direct contact with mantle rock, promoting chemical leaching
- Dark red surface materials contain salts, probably from the ocean

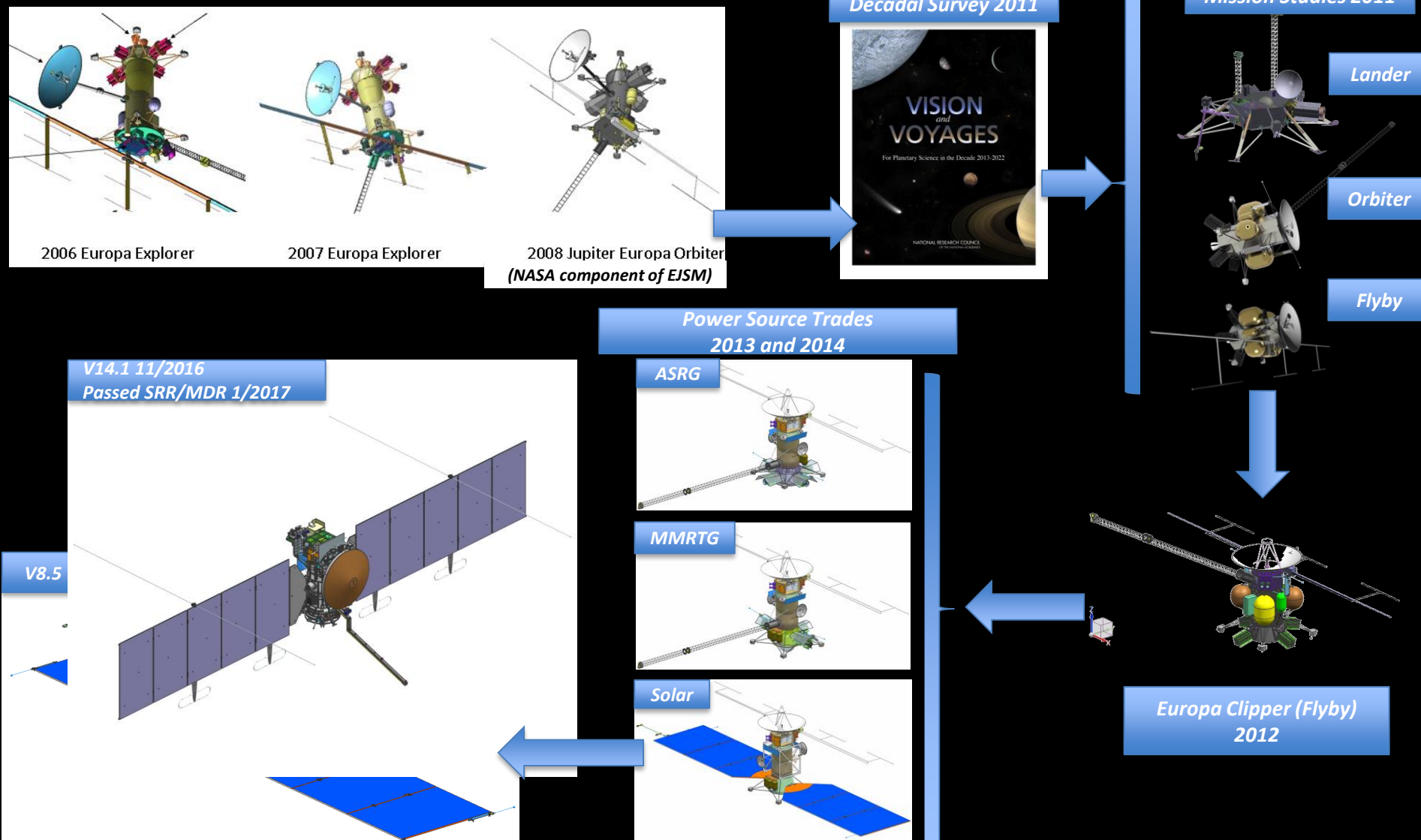
Energy:

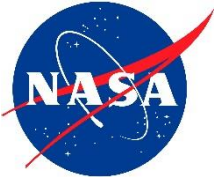
- Chemical energy could sustain life
 - Surface irradiation creates oxidants
 - Mantle tidal heating could create reductants
- Geological activity would “stir the pot”

***The planned Europa mission
would test habitability hypotheses***

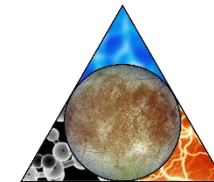


The long road to the current concept

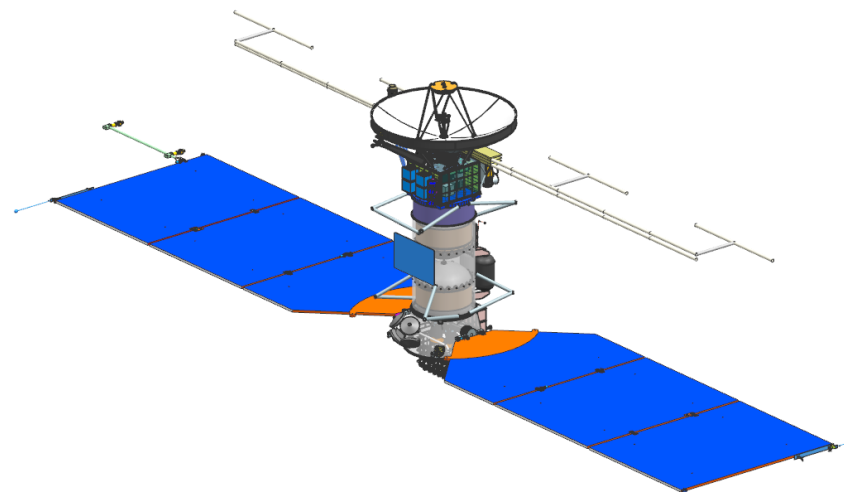




Major Changes since 2015



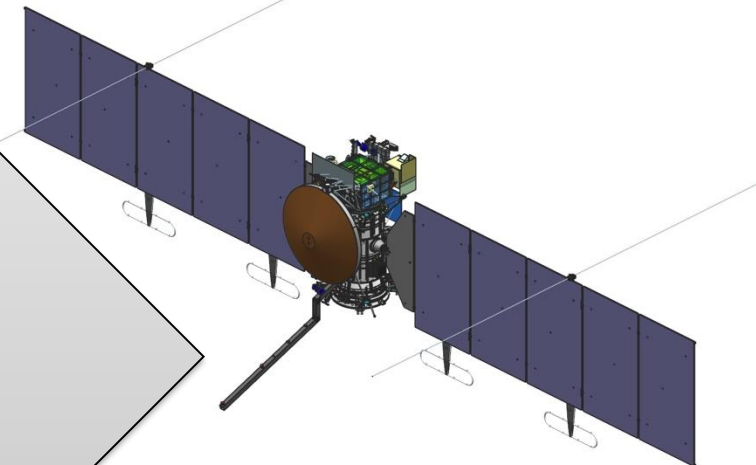
Version 8.5
(MCR)



- 1800 kg FS Dry mass
- 190 Ah Battery
- 66 m² Solar Array area
- 4.4 TB Downlink capability

- Accommodated selected instruments (10)
- Bigger Solar Array & Battery
- Dozens of optimization trades
- Engine Architecture
- Baselined 15F10 trajectory: 42 Europa flybys, 2.8 Mrad EOM dose
- Addition of SLS Block 1B and Delta IV Heavy; removal of Atlas V 551 from compatible launch vehicles list
- Back up Lander Relay

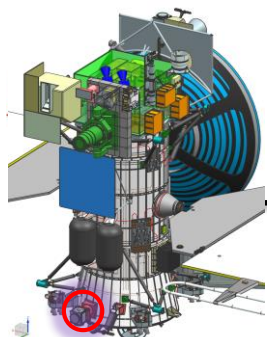
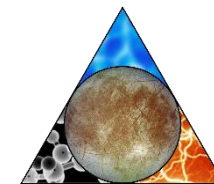
Version 14.2
(SRR/MDR)



- 2300 kg FS Dry mass
- 350 Ah Battery
- 90 m² Solar Array area
- 5.5 TB Downlink capability

Significant Maturation of Spacecraft with Selected Instruments

Science Instruments Accommodated



PIMS
(lower)

PIMS
(upper)

SRU
(2x)

MISE

EIS-WAC

EIS-NAC

Instrument
Deck

E-THEMIS

UVS

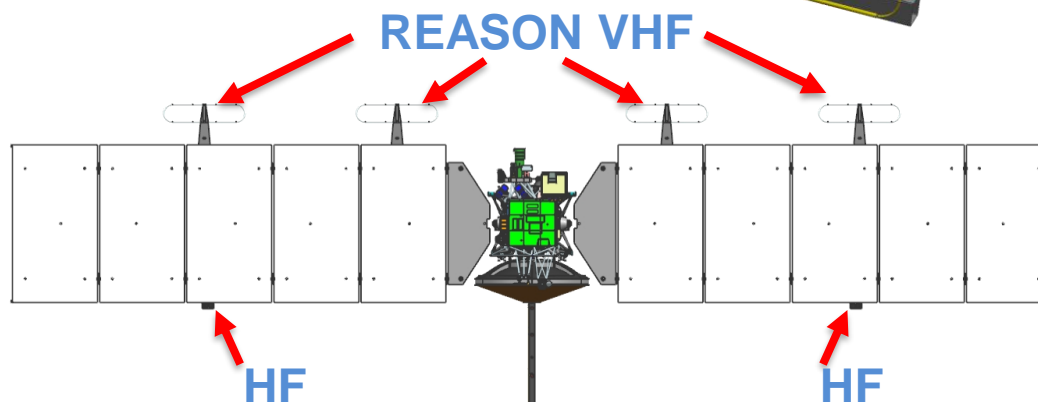
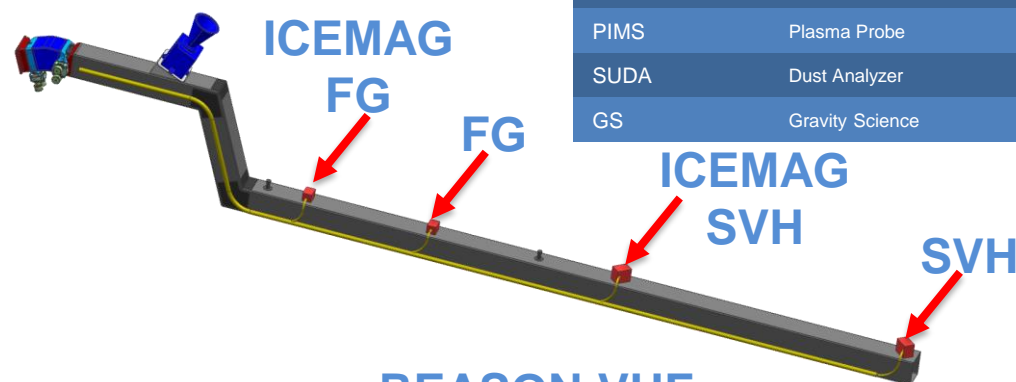
MASPEX

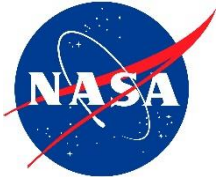
SUDA

- Composition
- Geology
- Ice & Ocean

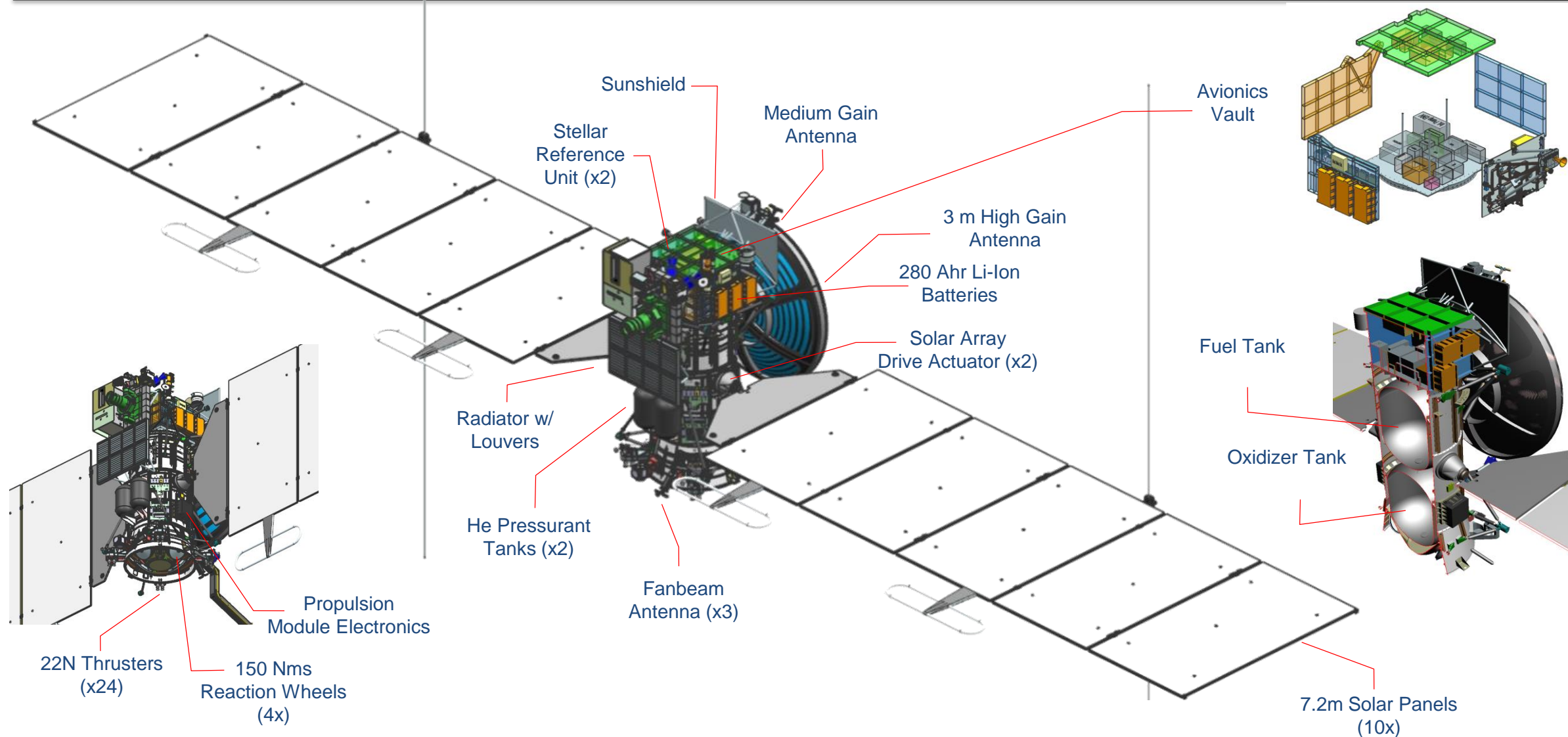
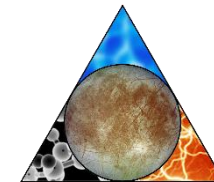
Selected Science Payload

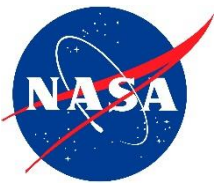
Acronym	Instrument
REASON	Ice Penetrating Radar
EIS NAC/WAC	Topographical and Reconnaissance Imager
MISE	Shortwave Infrared Spectrometer
E-THEMIS	Thermal Imager
ICEMAG	Magnetometer
MASPEX	Neutral Mass Spectrometer
PIMS	Plasma Probe
SUDA	Dust Analyzer
GS	Gravity Science



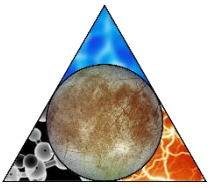


Flight System Configuration





Major Trades Completed & Future Major Trades



Completed and Incorporated Trades	Selected
Main Engine Trade	25N engine clusters for Main Engine and RCS
Vehicle Configuration	HGA on -X, Nadir Deck attached to vault
REASON accommodated	REASON mounted to SA – articulated arrays
Avionics/Payload Data Interface Trade	SpaceWire for High Speed, UART for Low Speed
Instrument Nadir Deck Thermal Design	Nadir Deck isolated from Thermal Loop
MISE Thermal Trade	Cyrocooler
ICEMAG Boom	Rigid 2-hinge 5m boom
Active vs Passive Thermal Architecture	Active fluid loop
REASON Redundancy	Partial redundancy
ZTJ vs UTJ Solar Cells	ZTJ contract selected
Vault Architecture	Hinged design - mounting on all interior surfaces
Reaction Wheels	4x18” Reaction Wheels mounted in PM Skirt
Emergency Communication Mode	10 bps and Tones

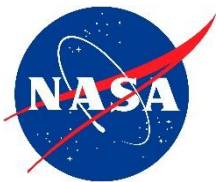
Trades Completed (Ready to be incorporated)

- Tank size to take advantage of additional Lift Mass
- SSIRU vs MIMU
- Radiator Louvers, Throttle Valve
- CSS Placement
- SA Cell Size

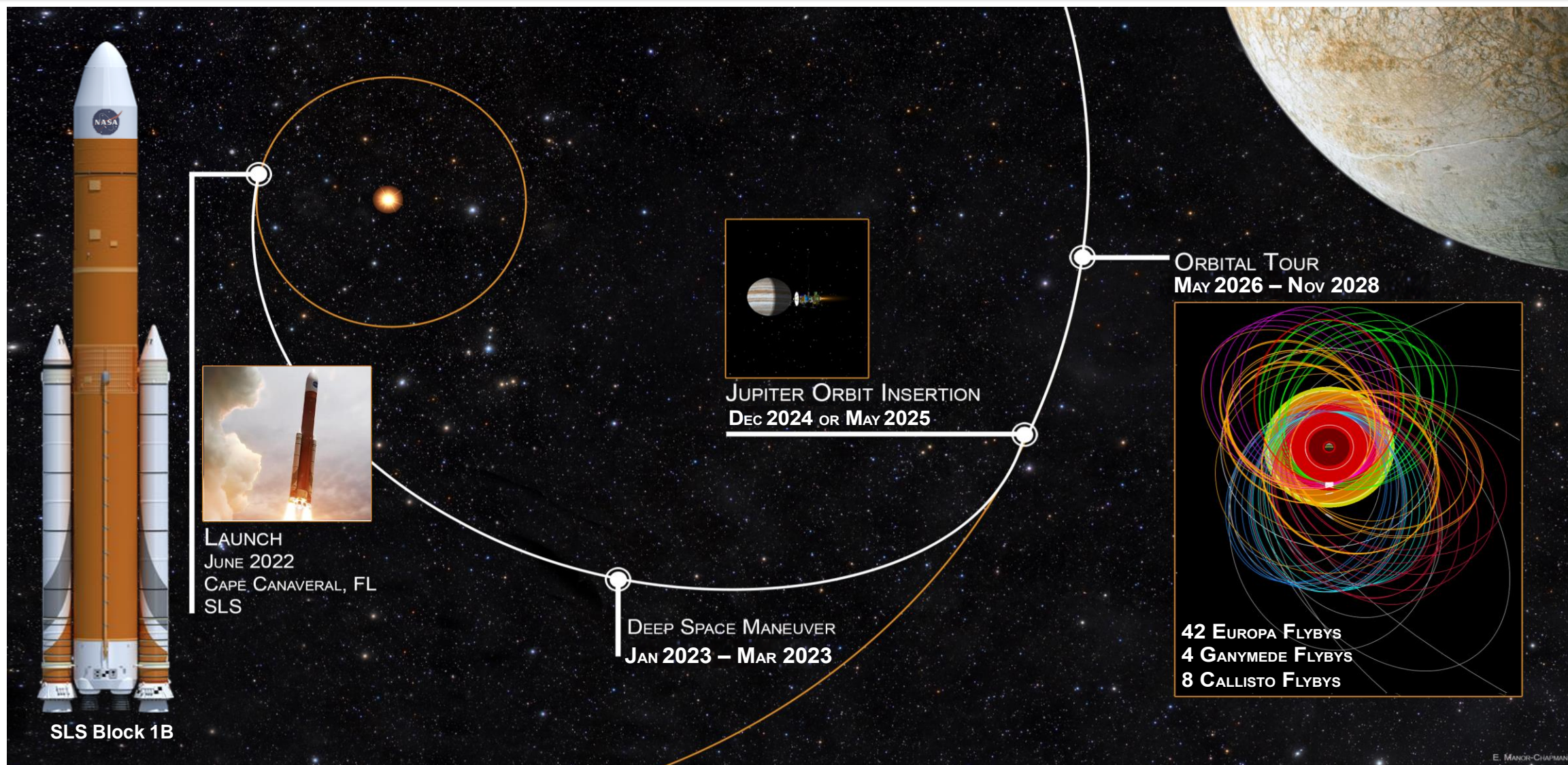
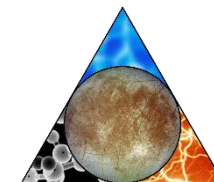
Future Trades

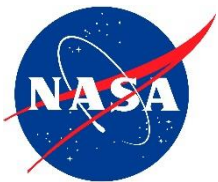
- RCS vs RWA during cruise
- RF Vault Location
- SA Challenge Implementation
- 1 hinge Mag Boom
- LV Separation System
- SA Deployment Approach
- Thermal Hybrid Approach
- ICEMAG SRU Removal / Boom stiffness
- Resolve 10 bps continuous usage
- Integrated vs Modular Shipping

Future Trades Identified to Reduce Risk

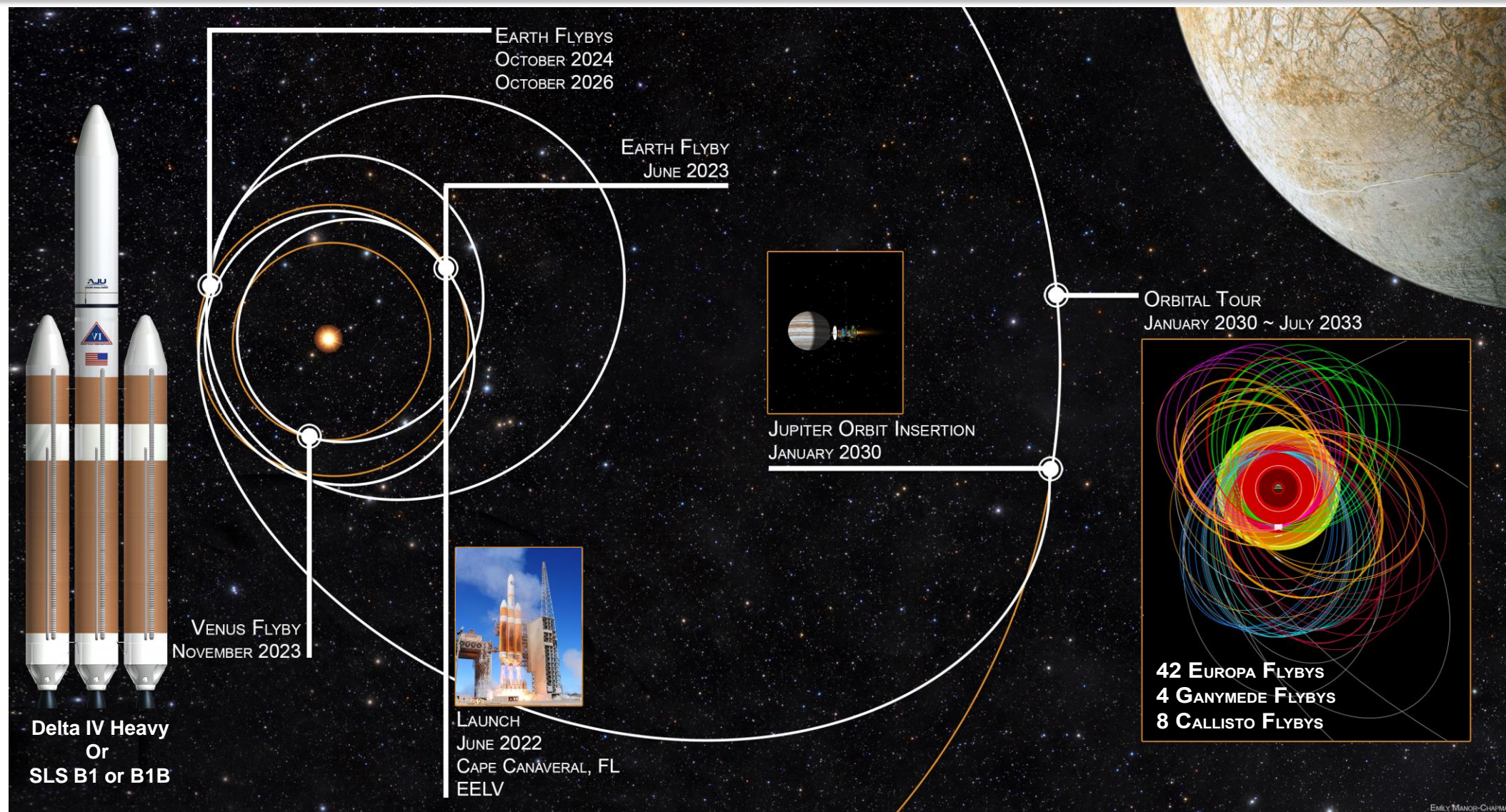
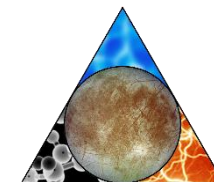


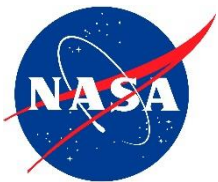
Direct Interplanetary Trajectory Option



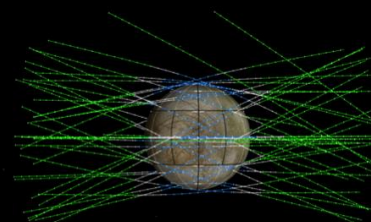
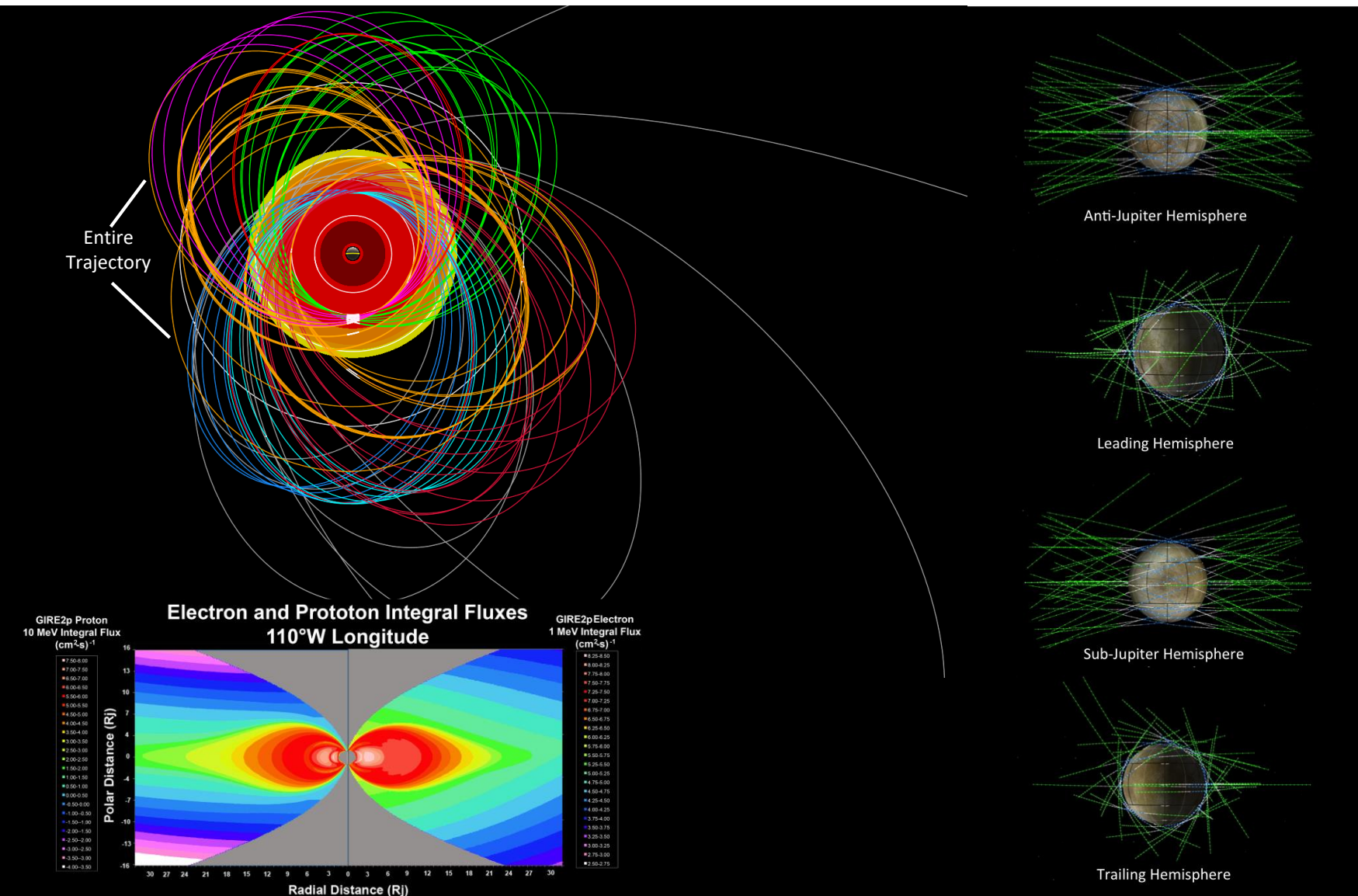
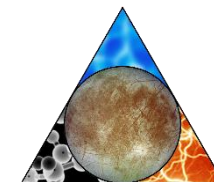


EVEEGA Interplanetary Trajectory Option

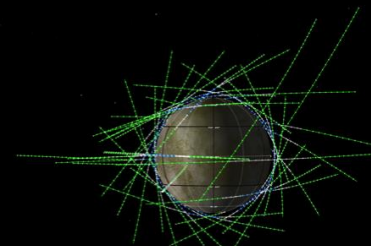




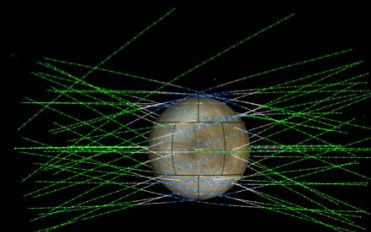
Jupiter Tour Design Strategy



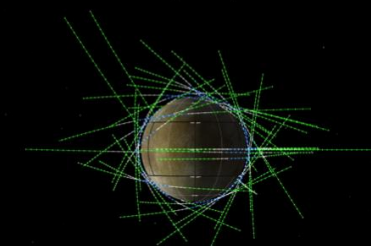
Anti-Jupiter Hemisphere



Leading Hemisphere

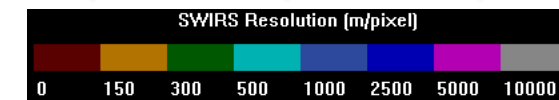
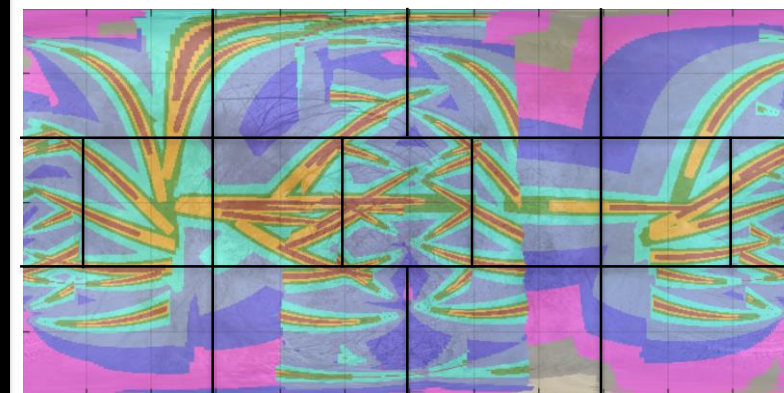


Sub-Jupiter Hemisphere

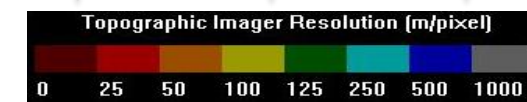
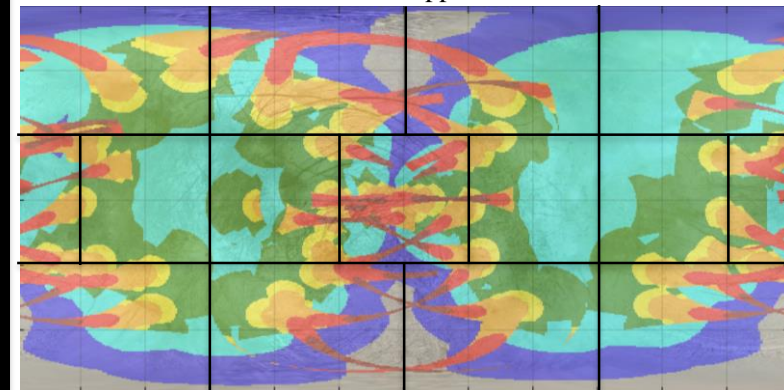


Trailing Hemisphere

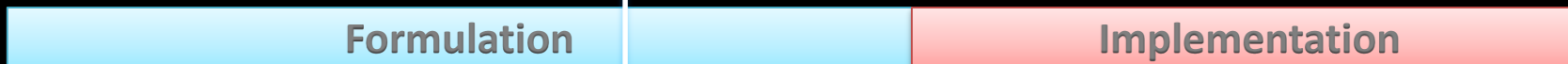
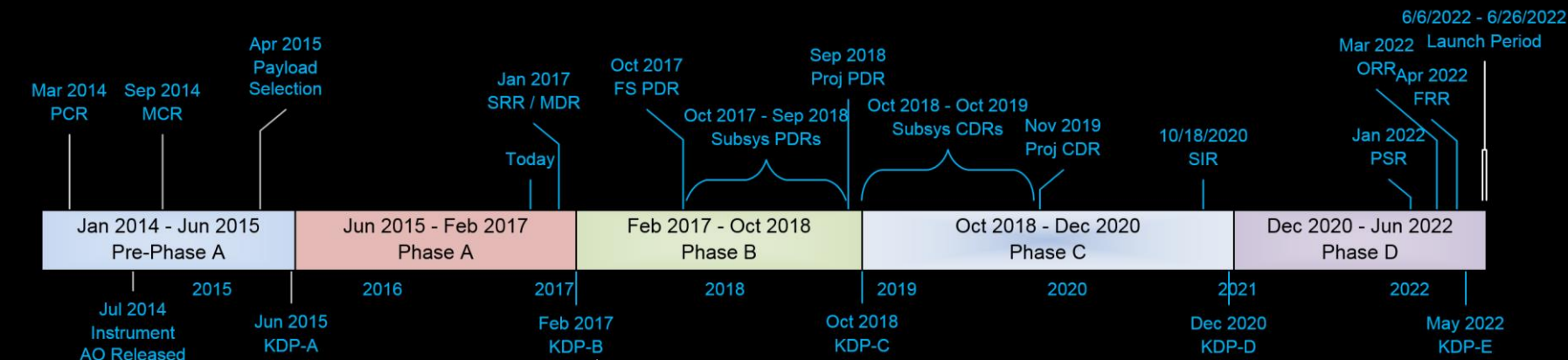
MISE Opportunities



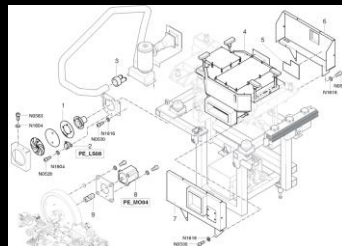
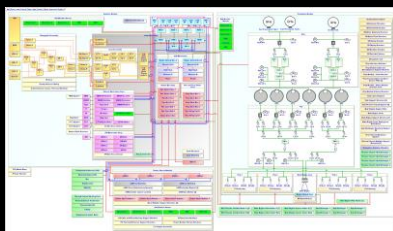
EIS WAC Opportunities

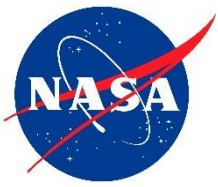


Europa Clipper Project Schedule

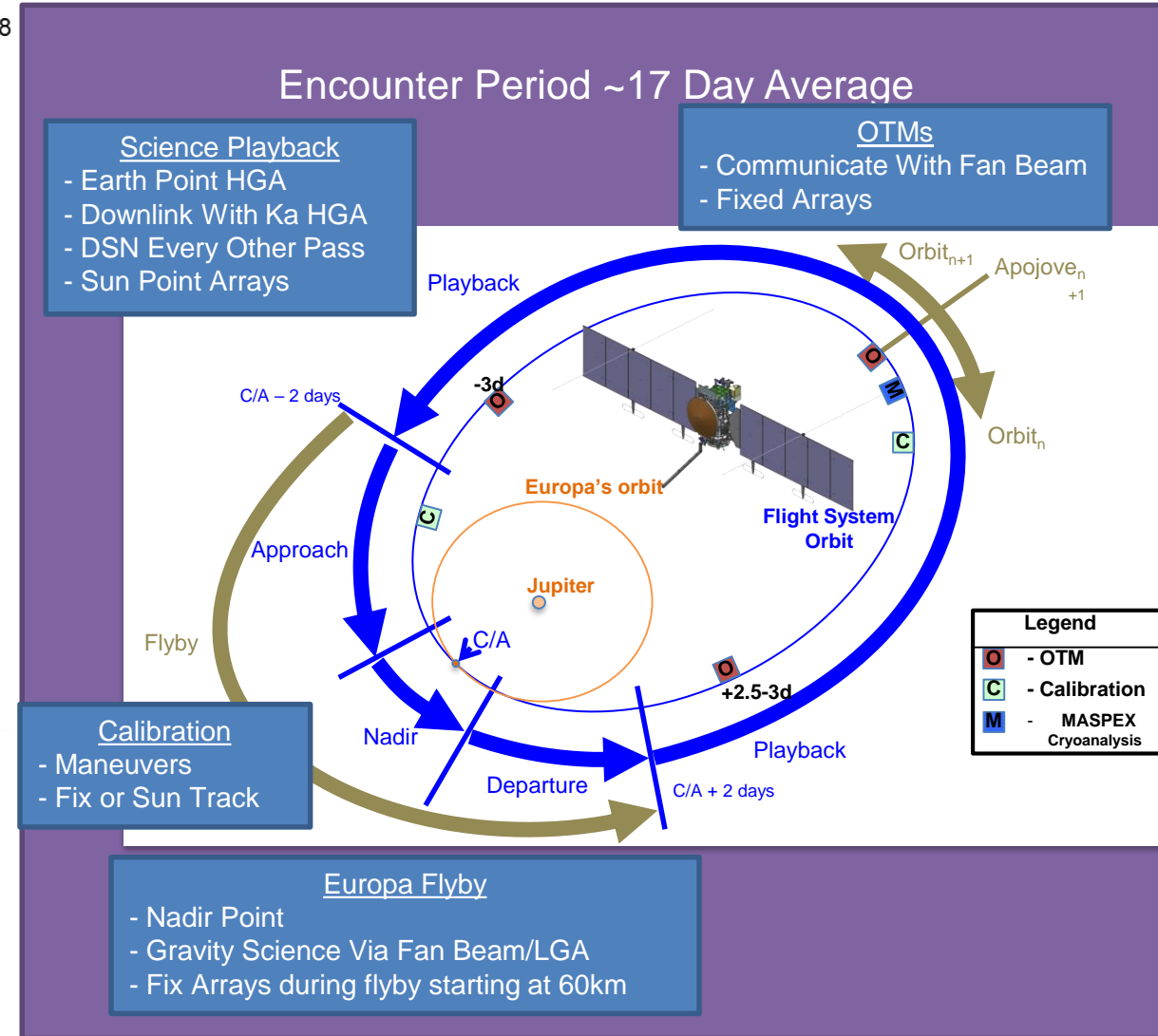
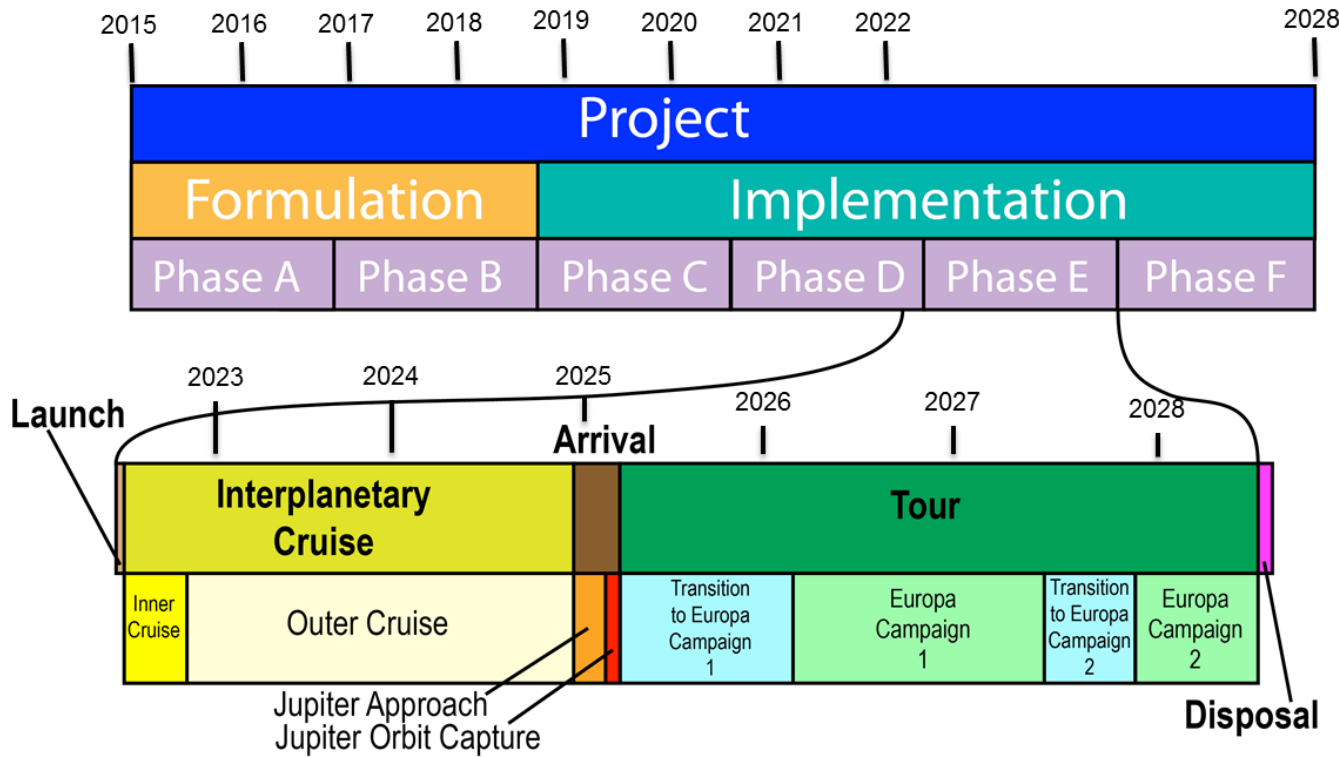
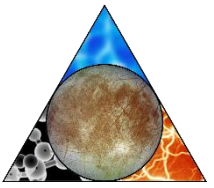


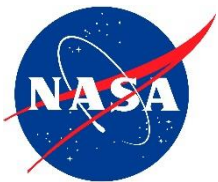
We are
here



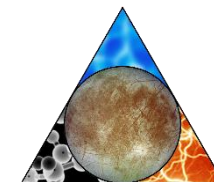


Project Timeline, Phases & Modes

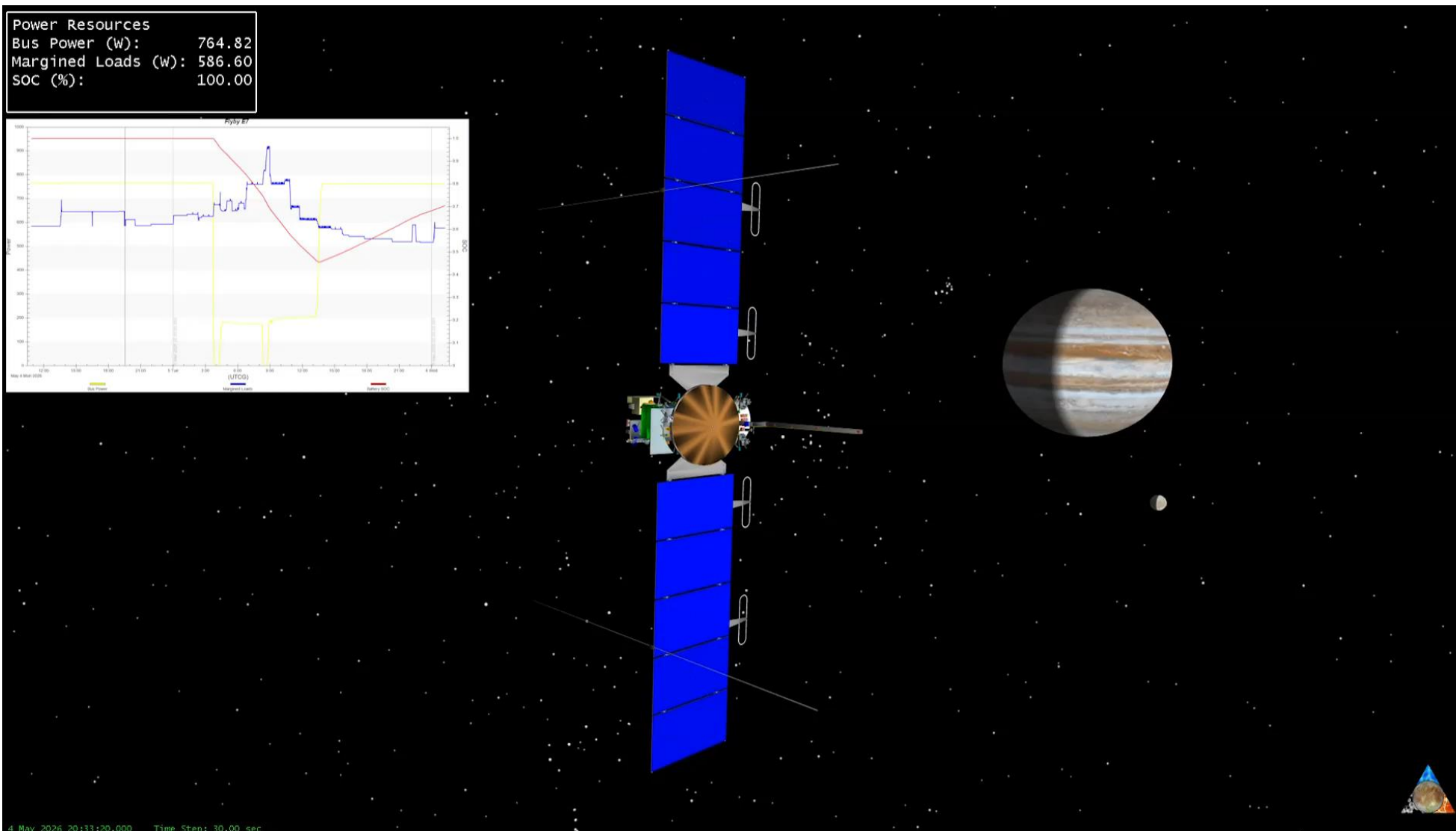


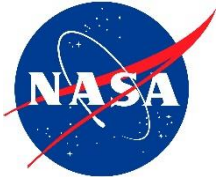


Typical Europa Flyby

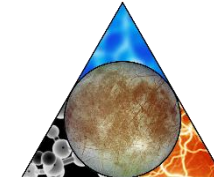


E7 Flyby
Animation





What's next?



- PDRs!